

Communicating Leave No Trace Ethics and Practices: Efficacy of Two-Day Trainer Courses

Melissa L. Daniels
Jeffrey L. Marion

EXECUTIVE SUMMARY: Heavy recreational visitation within protected natural areas has resulted in many ecological impacts. Many of these impacts may be avoided or minimized through adoption of low-impact hiking and camping practices. Although “No Trace” messages have been promoted in public lands since the 1970s, few studies have documented the reception and effectiveness of these messages. The U.S. Leave No Trace Center for Outdoor Ethics develops and promotes two-day Trainer courses that teach Leave No Trace (LNT) skills and ethics to outdoor professionals, groups, and interested individuals. This study examined the change in knowledge, ethics, and behavior of LNT Trainer course participants. The respondents were a convenience sample of participants in Trainer courses offered from April through August 2003. Trainer course instructors administered pre-course and post-course questionnaires to their participants, and we contacted participants individually with a follow-up questionnaire 4 months after completion of their course. Scores for each of the sections increased immediately following the course, and decreased slightly over the 4 months following the course. Overall, more than half of the knowledge and behavior items, and half of the ethics items, showed significant improvement from pre-course measures to the follow-up. Age, reported LNT experience, and backpacking experience affected the participants’ pre-course knowledge and behavior scores. Younger, less experienced respondents also showed a greater improvement in behavior following the course. Trainer course participants also shared their LNT skills and ethics with others both formally and informally. In summary, the LNT Trainer course was successful in increasing participants’ knowledge, ethics, and behavior, which they then shared with others. Since many low-impact skills taught in the LNT curriculum are supported by scientific research, LNT educational programs have the potential to effectively minimize the environmental impacts caused by outdoor recreationists. Research implications for improving LNT training and instruction are described.

KEYWORDS: Leave No Trace, environmental education, education evaluation, outdoor ethics.

AUTHORS: Melissa L. Daniels is a M.S. graduate student with the Department of Forestry at Virginia Tech. Jeffrey L. Marion is a Unit Leader/Research Scientist, USGS Patuxent Wildlife Research Center, Virginia Tech Field Station, Department of Forestry (0324), Blacksburg, VA 24061. All correspondence should be directed to Marion at 540-231-

6603, email: jmarion@vt.edu. The authors extend their thanks and appreciation to Ben Lawhon, Director of Education, Leave No Trace Center for Outdoor Ethics, for his review and assistance in implementing this survey, to the numerous Leave No Trace Trainer course instructors who assisted with the distribution and collection of questionnaires, and to Joe Roggenbuck and Steve McMullin for their guidance and reviews of this paper.

Introduction

As outdoor recreation grows in popularity, protected natural areas may suffer from overuse and high impact behaviors. Outdoor visitors engage in an increasingly diverse array of recreational activities that can degrade both natural environments and the quality of experiences for other visitors. Many impacts can be avoided and others minimized if visitors alter their behavior through the adoption of low-impact practices. The U.S. Leave No Trace (LNT) program has become an international authority on low-impact skills and ethics for outdoor activities. Guided by the Leave No Trace Center for Outdoor Ethics, and with the participation of numerous governmental, commercial and nonprofit partners, the LNT program has developed educational literature and courses to encourage adoption of low-impact skills and ethics for nonmotorized outdoor recreationists. Their curriculum is supported by scientific studies of visitor impacts, but few studies have documented the degree to which LNT practitioners gain, retain, or apply the knowledge, practices, and ethics that are promoted. This study evaluates the efficacy of the two-day LNT Trainer course developed and authorized by the Center for Outdoor Ethics.

Literature Review

Recreation Resource Impacts

The term recreation ecology describes “the study of ecological interrelationships between humans and the environment in recreation/tourism contexts” (Leung & Marion, 2000). This field of study seeks to protect natural resources from recreation-related degradation through an enhanced understanding of use/impact relationships and the influence of environmental and managerial factors. Recreation visitation to protected environments can lead to unacceptable levels of vegetation loss, soil exposure, soil erosion, tree damage, litter, human waste, and wildlife disturbance (Leung & Marion, 2000). Similarly, recreation visitation at popular areas can result in visitor crowding and conflicts (Manning, 1999). When severe, these impacts compromise management goals by degrading natural conditions and processes within protected lands and the quality of recreation experiences.

Impacts to campsites and trails are caused by a variety of factors. Scientists have examined the numerous visitor and site characteristics that

affect the amount and severity of resource impacts. For example, campfire-related impacts such as tree damage and large charcoal-filled fire pits can be avoided when visitors forgo a campfire or minimized when they collect only small pieces of dead wood on the ground, build small fires, and burn all wood to ash (Reid & Marion, 2005). Cole (1995) examined the amount of impact on campsites used one night versus four nights and found that the campsites used four nights had less than twice the amount of impact as those used one night. This and other studies (Cole, 1992; Marion & Cole, 1996) have described an asymptotic use–impact relationship whereby the majority of the resource impact occurs with initial and low levels of use, with diminished amounts of impact associated with further increases in use. These findings indicate that resource impacts can be minimized by either dispersing use widely or concentrating use on a limited number of high-use sites (Leung & Marion, 1999).

Hammitt and Cole (1998) identified group size, activity type, visitor behavior, and use distribution as the primary factors influencing the amount of impact. Cole (1992) employed amount of use, vegetation fragility, vegetation density, and degree to which activities are concentrated spatially to model and predict impacts on hypothetical campsites. Marion and Cole (1996) found that grasses and sedges demonstrated significant resistance and resilience to trampling, while broad-leaved forbs were damaged more easily and recovered more slowly. These findings highlight the potential importance of altering visitor behavior, for example, by spatially concentrating trampling activities to resistant vegetation or surfaces to avoid or minimize resource impacts. Similarly, experiential qualities can be improved when recreationists take breaks or camp away from trails and other campsites, are courteous to other visitors, and visit in smaller groups (Manning, 1999).

Recreation impacts are a result of the interaction between ecological site characteristics and visitor behaviors. Studies limited to resource conditions may be insufficient for understanding and correcting problems. Effective low-impact education programs require the integration and application of recreation ecology and social science knowledge. Educators need to understand the underlying causes of damaging behaviors, as damage may result from visitors' careless, unskilled, uninformed, unavoidable, or illegal actions (Hendee & Dawson, 2002). Similarly, educators need to understand how visitor behavior contributes to visitor crowding or conflict and how these relate to recreation satisfaction (Manning, 1999). Social science helps to identify human tendencies in behavior, conditions and variables that influence behavior, and critical factors involved in personal decision making (Vander Stoep & Roggenbuck, 1996). By integrating knowledge gained from recreation ecology studies with insights about visitor behavior, visitors' perception of impacts, and effective methods for improving knowledge and behavior, managers can increase their success with educational programs that seek to avoid or minimize recreation impacts.

Environmental Education Programs

Environmental education (EE) is a method of indirect management that helps protect natural resources while promoting the “unconfined” nature of outdoor recreation (McCool & Christensen, 1996). Although many programs include knowledge and ethical or affective components, these are (arguably) of little value unless they produce a noticeable change in behavior. EE has become a popular tool to promote environmental awareness and behavioral change. In the Tbilisi Conference of 1977, the following objectives were identified for environmental education: awareness, sensitivity, attitudes, skills, and participation (Hungerford & Volk, 1990). A great variety of EE programs have been developed in pursuit of these goals. Although some scientists have questioned the effectiveness of EE, there is significant evidence that EE can improve environmental behavior (Manning, 2003; Zelezny, 1999). The effectiveness of EE programs depends on many factors, including the setting, duration of involvement, affective component, and discussion of practical actions.

Setting and Duration of Involvement

The LNT Trainer course usually lasts 2 days, with a focus on participatory experiential learning in the field, sometimes with a short classroom session. Zelezny (1999) suggests that the most effective environmental interventions take place in a classroom setting and involve active participation. Zint and others (2002) found that youth field trips were more effective in improving various indicators of the participants’ environmentally responsible behavior than a similar curriculum offered in schools. This study also found that longer programs produced a greater change in environmentally responsible behavior. Bogner (1998) surveyed students in a park-based outdoor ecology program and found that students in 5-day programs improved in environmental behavior relative to those in 1-day programs. Metzger and McEwen (1999) found an increase in environmental sensitivity of 12-19 year olds following the Environmental Ed-Ventures program, a 5-day trip with planned EE activities and an immersion in the environment. These studies suggest that active participation and a longer duration of involvement are important elements for improving the environmental behavior of participants.

Ethics and Values

A consistent commitment to avoiding damaging behaviors may require a strong environmental ethic. Ethics are prescriptive concepts of the way the world ought to be (Harding, Borrie, & Cole, 2000). Environmental ethics define the moral norms between people and the environment, and explain humans’ responsibilities toward the natural world (Des Jardins, 2001). Compliance with low-impact recommendations may reflect a type of environmental ethic rooted in an ethic of justice or of care (Harding et al., 2000). By shaping an individual’s ethics, educators seek to alter behavior on a voluntary basis, avoiding regulatory compulsion. The stated mission of the Center for Outdoor Ethics, “to promote and inspire responsible

outdoor recreation through education, research, and partnerships” (Leave No Trace Center for Outdoor Ethics, 2003), embraces a philosophy that LNT education can lead to the development of an environmental ethic.

Attarian (1996) suggested that values clarification is key to modifying behavior. He proposed a model and strategies for effectively integrating values clarification into LNT programs. The model employs a three-step approach (described by Harmin, Kirschenbaum, & Simon, 1973) with fact, concept, and value levels. The fact level concentrates on the LNT principles, the concept level on the concrete, practical applications of these principles, and the value level on the deeper personal and societal meanings of LNT. He also discussed strategies for teaching LNT, including role modeling, utilizing teachable moments, and encouraging students to keep a journal.

History and Efficacy of the Leave No Trace Program

LNT began in 1990 as an educational program offered by the U.S. Forest Service, with substantial developmental support from the National Outdoor Leadership School. It became a nonprofit organization in 1994, and is now widely recognized throughout the United States and internationally (Marion & Reid, 2001). The phrase “leave no trace” has broad application, describing the concept of low-impact outdoor skills and ethics for application across a diverse array of outdoor recreation activities and settings. The Leave No Trace Center for Outdoor Ethics develops and distributes a variety of educational materials in cooperation with government agencies, corporate sponsors, and other organizations. The program is based on seven general principles:

1. Plan ahead and prepare.
2. Travel and camp on durable surfaces.
3. Dispose of waste properly.
4. Leave what you find.
5. Minimize campfire impacts.
6. Respect wildlife.
7. Be considerate of other visitors.

The Center for Outdoor Ethics establishes guidance for two courses—a 2-day “Trainer” course and a more intensive, 5-day “Master” course. These courses are taught by LNT Master Educators and sponsored by a variety of agencies and organizations within the United States and internationally. The LNT Trainer focuses on communicating LNT practices; the Master course adds greater depth of instruction, experiential learning, discussion of rationales and ethics, and instruction/application of communication techniques. The primary intents of the Master and Trainer courses are that participants will train others and conduct public outreach.

Although few studies have directly evaluated the efficacy of low-impact education on ecological or social conditions, scientists have documented improvements in visitor knowledge in behavior. The theoretical basis for visitor education aimed at encouraging low-impact behaviors is reviewed

by Manning (2003) and Roggenbuck (1992). For example, Overton (1991) used experimental camping techniques to demonstrate that low-impact camping was less damaging to *Vaccinium* and *Potentilla* species than traditional camping methods. Low-impact messages, particularly with ecological appeals, can be effective in reducing campfire use and lakeshore camping (Christensen & Cole, 2000), and in reducing littering and tree damage (Oliver, Roggenbuck, and Watson, 1985). Although few studies have focused specifically on the LNT program, there is substantial evidence to support the benefits of educational programs that promote low-impact outdoor practices.

Dowell and McCool (1985) studied the effectiveness of the U.S. Forest Service's LNT program (a predecessor to the current program). They utilized a variety of presentation formats and found that all formats improved Boy Scouts' scores for knowledge, skills, beliefs, attitudes, and behaviors. Another study demonstrated increased environmental concern and a positive change in behavioral intentions following an extended National Outdoor Leadership School course. A follow-up evaluation showed a deterioration of theoretical constructs for responsible environmental behavior (subjective norm, concern for norm, knowledge, beliefs, locus of control, and personal responsibility) 4 months after the completion of the course (Hammit et al., 2003). While only a few other studies have directly evaluated the effectiveness of a low-impact education program, closely related research has shown great potential for the success of such a program.

Study Objectives

This study sought to evaluate the extent to which the LNT Trainer course improved short- and long-term knowledge, ethics, low-impact behavior, and subsequent LNT instruction provided to others. Specific research questions included: (1) Do course participants gain greater knowledge of LNT practices, improve their environmental ethics, and improve their low-impact behavior? (2) Are improvements short term or are they retained 4 months after the course? and (3) To what extent do participants teach others what they have learned? We also sought to learn about the strengths and weaknesses of LNT Trainer courses to gauge their effectiveness and to suggest improvements.

Methods

Research Design

This longitudinal study evaluated study participants at three times: immediately before the course (pre-course), immediately following the course (post-course), and 4 months after completion of the course (follow-up). We used a convenience sample of Trainer course participants. An e-mail describing the study was sent to all LNT Master Educators in the database at the Center for Outdoor Ethics (725 individuals). If one of these

individuals was planning to offer an LNT Trainer course between April and August 2003, she or he could contact us for more information about the study. We also visited the LNT web site for postings of course offerings, and contacted the course leader by e-mail or phone, asking if she or he was interested in participating in the study. Course leaders who agreed to participate in the study were sent a packet containing instructions for survey distribution, a form requesting more details about the course and the instructors' experience, and the appropriate number of pre- and post-course surveys. Students in the Trainer course were asked to participate, but participation in the study was not a requirement of the course. Survey respondents were asked for contact information with the pre-course survey, and they were contacted individually for the 4-month follow-up.

The convenience sample employed by the study may limit applicability to the larger population of Trainer course participants. Although none of the course instructors we contacted refused to participate, we were only able to communicate with those who publicized their courses on the LNT Web page or contacted us for information on the study. There may have been other courses taught during the study period by instructors who neither advertised their courses nor contacted us for information on the study.

Variation in the administration of the surveys was addressed by developing and applying a clearly worded standardized set of instructions for the course instructors to follow. Guidance provided by the Center for Outdoor Ethics defines a curriculum that describes the content and knowledge that must be taught in this 16-hour course. The Trainer course is taught across the country by a large number of instructors, a potential limitation in our evaluation. However, the standardized curriculum and use of a common set of training materials enhances comparability, and the greater need for evaluating the program as it exists was deemed essential so that findings would reveal the program's actual strengths and weaknesses.

Instrument

Pre-course survey. This survey evaluated the students' knowledge of LNT principles, their ethical orientation toward the outdoors, and their use of low-impact practices on a recent camping trip. This survey was administered prior to course instruction (Table 1).

Post-course survey. This survey contained the knowledge and ethics sections and was administered at the completion of coursework.

Follow-up survey. This survey contained the knowledge, ethics, and reported behavior sections (if respondents had taken an outdoor trip after their course), as well as a section assessing the extent to which they had communicated LNT practices to others. It was administered 4 months after course completion. Those participants who provided e-mail addresses with their original course surveys were directed to a web-based survey (but offered the option of a paper copy), while those who gave only postal addresses were sent a paper copy and notified of the online survey.

Table 1
Components of Each of the Questionnaires

	Knowledge	Ethics	Behavior	Teaching
Pre-course	✓	✓	✓	
Post-course	✓	✓		
Follow-up	✓	✓	✓	✓

The knowledge section of the surveys comprised 25 items asking participants to identify the most acceptable LNT behavior or idea from four possible responses. The ethics section contained 16 Likert scale items asking the respondent to choose the level of agreement or disagreement with statements about ecological or LNT principles. Some items were reverse-coded. The behavior section asked respondents to choose one of three responses that most closely corresponded to their behavior on a recent camping trip.

The teaching section documented how the participants had used informal contacts and conversations, written media, and backcountry or frontcountry presentations and workshops to teach LNT practices. It also asked participants to estimate how many people they may have reached with LNT messages.

Analysis

Answers for the knowledge section were coded correct (1) or incorrect (0), to calculate scores for each respondent and the percent of respondents who answered each item correctly. When calculating the respondents' individual scores, skipped questions were counted as incorrect unless an entire page was skipped. If an entire page was skipped, the percent correct was based on the total correct for the remaining pages. For the ethics section, items were coded 1 (lowest agreement with LNT ethics) to 7 (highest agreement with LNT ethics), with corrections for the reverse-coded items. Behavior questions were coded 1 (least appropriate LNT behavior), 2, or 3 (most appropriate behavior). We used SPSS Version 12.0 for all analyses. Because the option of an online survey could create some differences in responses, the online and paper questionnaires were examined for significant differences. Fewer than 5% of the items showed significant differences, which was equivalent to the type II error rate; therefore, we treated the online and paper follow-up questionnaires as one group.

Paired *t*-tests were performed to find significant differences in the scores for each item between pre/post, pre/follow-up, and post/follow-up. An independent samples *t*-test revealed significant differences in the overall scores for the respondents for each comparison. We received a total of 166 pre-course, 156 post-course, and 112 follow-up surveys. The instructors reported 185 participants; therefore, 90% of course participants provided usable pre-course surveys. Based on the pre-course sample, we had a 94% response rate for the post-course survey and a 67% response for

the follow-up. Most follow-up questionnaires were received between 4 and 6 months following the course; however, all questionnaires were accepted as long as they were received before data analysis began. Since paired comparisons were used for the analysis, we had 156 pre/post pairs, 106 post/follow-up pairs, and 110 pre/follow-up pairs.

The effects of age, education, and outdoor experience on the participants' initial scores and receptiveness to LNT messages were also investigated. We examined the variables age (14-20, 21-30, 31-50, 51+), highest grade level completed (elementary/some high school, high school/some college, bachelor's degree/some graduate school, master's, Ph.D. or equivalent), reported LNT expertise (novice, intermediate, advanced, expert), backpacking frequency (days/year: 0, 1-4, 5-11, 12+), and years of backpacking (0, 1-3, 4-9, 10+). The groupings were determined by using or combining the categories present on the questionnaire (LNT expertise and education), or by examining the frequencies for a relatively equal distribution and/or gaps (age and backpacking experience). For the age category, an even distribution would collapse the last two categories, but we felt this was too wide a range. For each of these items, we performed an analysis of variance (ANOVA) and Tukey's honestly significant difference (HSD) for the respondents used in the paired *t*-tests. We examined ANOVAs and multiple comparisons for each item in the pre-course and follow-up questionnaires, and the percent improvement in score (follow-up minus pre-course, divided by pre-course).

Results

Knowledge

The mean score for all knowledge test items significantly improved by 11%, from a mean pre-course score of 70% correct to a post-course score of 82% (Table 2). A small but significant 3% drop from post-course to follow-up was offset by a significant long-term (pre-course to follow-up), 8% improvement. Of the 25 knowledge questions, 17 (68%) showed significant improvement pre-course to post-course, with the greatest improvements in the questions regarding repackaging food, hiking off-trail in a pristine area, and disposing of campfire ashes (Table 2). Only one item showed a significant decline from post-course to follow-up: encounters with horseback riders. Thirteen items showed improvement from pre-course to follow-up, with the same three items (as pre-course to post-course) showing the largest improvements. Several items did not show large improvements because course participants were already knowledgeable on that topic prior to the course. More than 90% of respondents answered five items correctly on the pre-course survey: bear precautions, cooking only what you need and packing out wrappers, picking wildflowers, camping in popular areas, and gathering wood. Two items began with low scores and did not show significant improvement from pre-course to follow-up. These included reasons for leaving a deer antler, and when wildlife are least sensitive to disturbance. Two items began with low scores and showed

Table 2
Knowledge test mean scores and score comparisons¹

Item	Pre	Post	Follow-up	Pre- post	Post- follow-up	Pre- follow-up
Overall	70.06	81.79	79.25	11.23**	-3.40**	8.24**
Leaving a deer antler	42.33	53.29	48.62	8.78**	-1.00	1.88
Disposing of campfire ashes	41.46	73.38	63.64	30.92**	-8.74	21.45**
Bear precautions	99.37	99.35	97.27	0	-1.94	-1.92
What to do when breaking camp	76.58	86.09	87.16	7.04*	2.00	4.85
Human waste disposal	87.35	95.45	91.74	8.44**	-3.92	3.67
Cooking only what you need, packing out wrappers	99.40	99.35	100.00	0	0.97	0
Consideration for other visitors	79.75	92.11	93.58	10.14**	0	13.21**
Disposing of dishwater	80.72	97.37	100.00	15.89**	0	15.45**
Using an existing fire ring	82.50	87.01	87.27	4.73	-3.88	-0.94
Picking wildflowers	96.99	99.35	97.27	2.60*	-0.97	1.82
Repacking food	70.91	92.11	95.45	23.33**	2.97	27.27**
What to do at an open gate	83.02	86.09	86.11	2.80	1.01	1.94
Encounter with horseback riders	48.41	82.24	65.74	31.25**	-18.18**	17.11**
Large group camping	31.10	47.10	43.64	16.45**	-7.77	11.93*
Procedure for traveling off-trail in a pristine area	48.13	77.12	77.06	27.89**	2.97	26.14**
Camping in popular areas	92.77	92.76	94.44	-0.66	-1.01	1.85
Traveling through a pristine area	12.65	32.90	25.69	20.13**	-7.84	13.76**
When wildlife area least sensitive to disturbance	43.13	53.90	44.95	11.49*	-7.84	1.12
Choosing a campsite	74.10	89.47	86.36	15.23**	-4.95	7.44*
Best time to visit a popular area	82.42	79.22	74.55	-3.92	-7.77	-6.36
Resistant/resilient vegetation	63.03	82.47	77.06	19.08**	-6.86	13.89*
Learned responses of wildlife	79.52	86.36	84.55	5.84	0	6.07
The only acceptable waste to leave behind	86.16	96.77	93.64	9.52**	-2.91	8.65**
When wildlife approach	60.63	65.36	66.36	5.41	0.98	9.52*
Gathering wood	89.16	98.06	99.09	6.49*	0.97	10.00**

¹Mean scores are based on percent correct. Scores are based on mean for all respondents, whereas Differences in scores are based on paired comparisons.
* $p < .05$; ** $p < .01$

significant improvement from pre-course to follow-up; however, the improved scores were still below 50% correct across respondents: large-group camping, and traveling through a pristine area.

We also examined the data for trends related to age, education, and outdoor experience. We were particularly interested in changes from the pre-course survey to the follow-up. ANOVAs for age, education, LNT expertise, and number of years of backpacking experience showed significant differences on the pre-course survey, whereas days per year of backpacking did not. For each of these categories, respondents in the lower categories (younger, less education, less experience) tended to receive lower scores. For the follow-up tests, there were fewer significant differences, with ANOVA showing significantly higher scores for those with more education and a greater number of years backpacking. ANOVA testing on percent improvement in the scores yielded no significant effects.

Behavior

Reported LNT behavior while on a recent camping trip was assessed at two points in time—pre-course and follow-up. All mean scores for the items were above the middle response of 2, indicating that most respondents chose the most appropriate or middle behavior, even prior to the course (Table 4). “Camp proximity to others” and “Disposing of dishwater” had the lowest initial scores. The overall mean score showed a significant improvement of 0.20. Individual scores for 7 of 10 items also improved significantly. The items related to repackaging food and disposing of dishwater showed the greatest improvements. The items for which the respondents showed the most appropriate behavior after the course were “hiking through popular areas,” and “trash disposal.”

Table 4
Behavior Mean Scores and Score Comparison¹

	Pre	Follow-up	Pre-follow-up
Overall	2.49	2.72	.20**
Repackaging food	2.28	2.64	.39**
Awareness of regulations	2.42	2.79	.28**
Substrate for tent placement	2.65	2.77	.12
Hiking through popular areas	2.73	2.94	.14*
Disposing of dishwater	2.26	2.57	.33**
Trash disposal	2.72	2.91	.13*
Keeping souvenirs	2.80	2.77	.02
Campfire practices	2.28	2.42	.24**
Bear precautions	2.56	2.79	.14
Camp proximity to others	2.25	2.58	.24*
¹ Scores are based on a scale of 1-3, where 3 is the most appropriate response. Differences in scores are based on paired comparisons. * $p < .05$; ** $p < .01$			

We examined several demographic variables on reported behavior for the pre-course and follow-up questionnaires, and percent difference. The pre-course survey showed significant differences in behavior depending on self-evaluated LNT expertise and backpacking experience. Those respondents indicating no backpacking experience and ranking themselves as LNT novices scored significantly lower than those with more experience.

For the follow-up survey, no significant differences were found in reported behavior, although number of years backpacking had an ANOVA p -value of .056, with the 4 to 9 year group showing the highest scores for the Tukey's HSD comparison. When behavior was computed as percent improvement, age and LNT experience showed a significant inverse relationship, with the younger, less experienced respondents showing greater improvements in behavior. Backpacking experience also showed an inverse relationship, with an ANOVA p -value of .056 for backpacking frequency and .051 for number of years backpacking. Tukey's HSD revealed that individuals with no backpacking experience had greater improvement in behavior than those who backpacked 12 days/year or had been backpacking for 10 or more years.

We examined Pearson correlations among the variables and found a significant correlation of .419 ($p = .002$) for change in ethics and change in behavior. The correlations for change in knowledge to change in behavior, and change in knowledge to change in ethics were not significant: .129 and .206, respectively.

Outreach

In the follow-up survey, we asked respondents to what extent they had taught LNT practices to others. Of the 112 respondents, 94% conveyed LNT information and practices to others. Thirty percent had taught LNT once or twice since the course, 24% taught LNT once or twice a month, and fewer than 20% each had taught LNT "once a week" and "a few times a week." For 44% of those who had shared their LNT skills, their teaching was part of a job or internship. Ninety-two percent of these respondents had used informal contacts and conversations to teach LNT, 35% percent had given formal presentations in the frontcountry, and 25% percent had given formal LNT presentations in the backcountry. Respondents had used a variety of media to convey LNT to others, most often posters or signs (31%), and pamphlets or brochures (40%). Apart from work responsibilities, 93% of respondents reported teaching LNT through informal contacts and conversations, most often to friends (74%) and family (66%). Ninety-one percent of respondents planned to teach the LNT message in the future.

Discussion

Test scores for the knowledge and ethics sections generally followed the expected pattern of significant improvement post-course, followed by a slight decline for the follow-up. Most of the follow-up scores were, however, significantly higher than the pre-course scores, indicating positive long-term effects. Since a long-term adoption of low-impact skills and ethics will have a greater effect on reducing impacts than immediate, short-term changes, the pre-course to follow-up change is the most important measure of course success. Significant improvements in pre-course to follow-up measures for overall knowledge, ethics, and behavior scores suggest the course is achieving its objectives. High overall scores of 79%,

6.13 (of a possible 7.00), and 2.73 (of a possible 3.0), respectively, indicate that LNT Trainer course participants are likely to retain a high level of consistency with low-impact skills and ethics in their outdoor pursuits.

As expected, there were declines in both knowledge and ethics scores from the conclusion of the course to the follow-up evaluation 4 months later. For the knowledge test, 15 of the 25 items declined, but only one declined significantly. For the ethics items, values for 12 of the 16 items declined, 5 significantly. Such declines can be attributable to participants' failure to remember all that they learned in the course, particularly factual information stored in short-term memory. This type of memory loss may be expected to further erode over time, particularly if not accessed and applied during frequent outdoor trips. However, we expect that low-impact practices that are experientially learned and applied during a course are less easily forgotten over time. Our research design was incapable of documenting and distinguishing these longer-term phenomena, and we recommend them as important topics for future longitudinal studies of greater duration.

Although overall scores demonstrate course success, individual items reveal the need for focusing attention on certain aspects of instruction, and possibly placing less emphasis on topics that are already known. In the knowledge section, significant improvements for 13 out of the 25 items, plus high scores for 5 other items, suggest that the remaining 7 items could be better addressed by the LNT Trainer courses. The items for which the follow-up survey showed the lowest score (regardless of significant improvement) require a more intensive focus in the Trainer course. Trainer course participants may not fully understand these issues, or they may not agree with the LNT perspective. The three items with noticeably low scores were "Reasons for leaving a deer antler," "Large group camping," and "When wildlife are least sensitive to disturbance." Greater discussion or examination of case studies may help the participants to better understand these issues and the rationale for LNT recommendations. Items with higher scores may require much less attention in the Trainer course. "Bear precautions," "Cooking only what you need and packing out wrappers," and "Picking wildflowers" all had pre-course scores above 95% correct. Concentrating on these items in an LNT Trainer course may be unnecessary as participants are already sensitive to these situations.

All ethics items received high scores. All but one item had a score higher than 5.75 on a scale of 1 to 7. This item—receiving a mean score of 5.46—was "It's OK to camp close to another group in the wilderness." (For this item, "strongly disagree" was considered the most ethical answer.) Many respondents had limited experience with wilderness camping, and may be accustomed to backcountry or frontcountry areas with designated campsites. In such areas it may be difficult to find a site away from other groups.

The respondents' reported change in LNT behavior, the most important effect of the Trainer course, was a clear success. All follow-up scores for behavior items were above 2.5 on a 3-point scale, indicating that more than

50% of respondents chose the best behavior for each item. Those items with the lowest averages were related to camping close to other groups, disposing of dishwater, and campfire practices. We surmise that the issue of camping close to other groups was difficult for many respondents because of experience camping in areas with designated campsites, or where they had little control over site spacing. Lower scores for dishwater disposal may be due to lack of planning ahead and carrying a strainer, or camping with a group that did not consider it necessary to strain food particles. The most appropriate response for campfire practices was "I did not have a campfire." For many outdoor enthusiasts, a campfire may be an important element of a high-quality experience. More than 50% of respondents did not have campfires on a trip following their Trainer course; some respondents made low-impact campfires.

Although camping away from others is not always possible, the issues of dishwater disposal and campfires may be improved in the Trainer course curriculum. If the deficiencies in dishwater disposal are caused by lack of preparation, this topic can be discussed in "Plan ahead and prepare" as well as "Dispose of waste properly." If the deficiency is more of a peer pressure/conformity issue, this topic can be stressed in discussions of teaching techniques and "Respect wildlife." Campfires are a difficult issue, due to both traditional notions of camping and peer pressure. The Trainer course could further emphasize alternatives to campfires and the importance of resource protection to minimize people's felt need or desire for a campfire.

When categorized by age, education, and experience, several relationships related to knowledge gain were revealed, but more significant differences were found for reported behavior. For knowledge, the variables of age, education, LNT expertise, and backpacking experience had some effect on their pre-course scores, but less on the follow-up and none on the percent improvement between the two tests. This indicates that the younger, less educated, and less experienced respondents were less knowledgeable about LNT before the course. Age, reported LNT expertise, and backpacking frequency had little effect on the follow-up survey. The similarity in scores for the follow-up indicates that those with initial low scores had greater improvement than those with initial high scores, but percent improvement was not statistically significant. For the pre-course survey, reported behavior showed significant differences between those with no backpacking or LNT experience, and those who had some experience. Percent improvement demonstrated significant relationships for these factors. Younger respondents, those with less LNT expertise, and those lacking backpacking experience showed a greater percent improvement.

The correlation between the change in ethics and change in behavior may reflect an important step in the persuasion process. There was no correlation between knowledge and behavior, suggesting that information may not be the most important tool in promoting appropriate behavior. We suggest that ethical appeals may be more important in promoting behavior

change than factual information. This suggests that the LNT program should focus more on our fundamental belief system, including morals that help us define what we understand to be good and right behavior. The courses should emphasize the need and reasons for certain practices, and their benefits to the environment, the individual, and other visitors. The importance for this is supported by McGuire's model of persuasion (McGuire, 1985). McGuire's model has six components, each essential for persuasion: exposure, attention, comprehension, yielding, retention, and actions (behavior). The knowledge portion of the LNT curriculum addresses the first three components, yet it may be ineffective unless the participants "yield" to the information. The course participants must also understand and accept the need for and importance of applying low-impact practices in order for them to alter their attitudes accordingly. Only if they accept and yield to the course instruction will they be likely to retain and use the information and begin practicing low-impact behaviors. In conclusion, teaching Trainers why it is important to minimize their impact is as important as how to minimize their impact.

The LNT Trainer course was also successful in promoting LNT outreach activity. Ninety-four percent of course participants taught LNT to others in some way, and 91% planned to teach it in the future. The most common method of teaching was through informal contacts and conversations, although many respondents also gave formal presentations. Many respondents also produced written media, especially within their jobs. This demonstrates that Trainer course participants have used their training to reach out to the community, usually through informal means. Even if it was not part of their job, a majority of LNT Trainers took an active role in sharing their knowledge and skills with others.

Conclusions

This research demonstrated that the LNT Trainer courses successfully promoted short- and long-term improvements in the participants' understanding and adoption of LNT skills and ethics. Trainer course participants improved and retained their knowledge, ethics, and behavior following the course. As important was the finding that 94% of course participants taught others what they had learned, demonstrating beneficial effects beyond course participation. Findings also suggest that course instructors should consider shifting some instructional time from topics that participants know well to topics that are less understood. Some demographic variables had significant effects on behavior, with younger and less experienced participants showing greater improvements in the use of low-impact practices.

Implications for improving the course by increasing or reducing the focus on selected curriculum topics were described. A principal finding was a significant correlation between a change in ethics and a change in behavior, suggesting that courses should include ethical appeals that emphasize the need and reasons for adopting LNT practices, in addition to

teaching the mechanics of the low-impact practices. This might be accomplished by discussing the consequences for natural area resources and visitors if no one applied LNT practices. Many different topics (e.g., campfire-related practices, human waste disposal, wildlife observation) should be explored and possible environmental and experiential consequences (e.g., large fire pits overflowing with partially burned wood, trash, and food; damaged and felled trees; large noisy groups camped a short distance away) should be experienced firsthand in the field or visualized through photos, personal life-experiences, or discussions of worst-case scenarios.

We suggest that the findings from this study also have implications for the 5-day LNT Master's course and similar courses that teach low-impact practices. In particular, the LNT Master's course covers essentially the same course content, providing greater time for experiential learning and instruction on teaching low-impact practices. Implications for these similar courses include identifying and focusing course work on those topics that are least understood by participants, and incorporating ethical appeals that emphasize the need and reasons for adopting low impact practices.

This study demonstrated that a 2-day LNT Trainer course significantly improved participants' knowledge, ethics, and behavior regarding low-impact recreational practices. We conclude that training courses similar to this one can be an effective tool for assisting managers of protected natural areas in achieving their objectives for sustaining recreational visitation while avoiding or minimizing associated resource impacts. Such courses, particularly when they teach low-impact practices and the importance and need for applying them, can be persuasive in teaching visitors to adopt practices that minimize the impacts of their visits.

References

- Attarian, A. (1996). Integrating values clarification into outdoor adventure programs and activities. *Journal of Physical Education, Recreation and Dance*, 67(8), 41-44.
- Bogner, F.X. (1998). The influence of short-term outdoor ecology education on long-term variables of environmental perspective. *The Journal of Environmental Education*, 29(4), 17-29.
- Christensen, N.A., & Cole, D.N. (2000). Leave No Trace practices: Behaviors and preferences of wilderness visitors regarding use of cookstoves and camping away from lakes. In D.N. Cole, S.F. McCool, W.T. Borrie, & J. O'Loughlin (Comps.), *Wilderness science in a time of change conference—Volume 4: Wilderness visitors, experience, and visitor management: May 23-27, 1999 ; Missoula, MT. Proceedings RMRS-P-15-VOL-4* (pp. 77-85). Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.
- Cole, D.N. (1992). Modeling wilderness campsites: Factors that influence amount of impact. *Environmental Management* 16, 255-264.
- Cole, D.N. (1995). Disturbance of natural vegetation by camping: Experimental applications of low-level stress. *Environmental Management* 19, 405-416.

- Culen, G.R., & Volk, T.L. (2000). Effects of an extended case study on environmental behavior and associated variables in seventh- and eighth-grade students. *The Journal of Environmental Education*, 31(2), 9-15.
- Des Jardins, J.R. (2001). *Environmental ethics: An introduction to environmental philosophy* (3rd ed.). Belmont, CA: Wadsworth/Thomson Learning.
- Dowell, D.L., & McCool, S.F. (1986). Evaluation of a wilderness information dissemination program. In R.C. Lucas (Ed.), *Proceedings-National wilderness research conference: Current research. July 23-26, 1985. Fort Collins, CO. General Technical Report-INT 212* (pp. 494-500). Ogden, UT: USDA Forest Service, Rocky Mountain Research Center.
- Fishbein, M., & Manfredo, M.J. (1992). A theory of behavior change. In M.J. Manfredo (Ed.), *Influencing human behavior: Theory and application in recreation, tourism and natural resources management* (pp. 29-50). Champaign, IL: Sagamore.
- Hammitt, W.E., & Cole, D.N. (1998). Wildland recreation and resource impacts. *Wildland recreation: Ecology and management*. New York: John Wiley & Sons.
- Harding, J.A., Borrie, W.T., & Cole, D.N. (2000). Factors that limit compliance with low-impact recommendations. In D.N. Cole, S.F. McCool, W.T. Borrie, & J. O'Loughlin (Comps.), *Wilderness science in a time of change conference—Volume 4: Wilderness visitors, experiences, and visitor management: 1999 May 23-27, Missoula, MT. Proceedings RMRS-P-15-VOL-4* (pp. 198-202). Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.
- Harmin, M., Kirschenbaum, H., & Simon, S.B. (1973). *Clarifying values through subject matter*. Minneapolis, MN: Winston Press.
- Hendee, J.C., & Dawson, C.P. (2002). *Wilderness management: Stewardship and protection of resources and values* (3rd ed.). Golden, CO: Fulcrum.
- Hungerford, H.R., & Volk, T.L. (1990). Changing learner behavior through environmental education. *The Journal of Environmental Education*, 21(3), 8-21.
- Leave No Trace Center for Outdoor Ethics. (2000). *Leave No Trace Trainer Course Guidelines*. 4 pp.
- Leave No Trace Center for Outdoor Ethics. (2003). *LNT home page*. Retrieved from <http://www.lnt.org>
- Leung, Y., & Marion, J.L. (2000). Recreation impacts and management in wilderness: A state-of-knowledge review. In D.N. Cole, S.F. McCool, W.T. Borrie, J. O'Loughlin (Comps.), *Wilderness science in a time of change conference-Volume 5: Wilderness ecosystems, threats, and management: 1999 May 23-27; Missoula, MT. Proceedings RMRS-P-15-VOL-5* (pp. 23-48). Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.
- Leung, Y., & Marion, J. L. (1999). Spatial strategies for managing visitor impacts in National Parks. *Journal of Park and Recreation Administration* 17(4), 20-38.
- Manning, R.E. (1999). *Studies in outdoor recreation: Search and research for satisfaction* (2nd ed.). Corvallis: Oregon State University Press.
- Manning, R.E. (2003). Emerging principles for using information/education in wilderness management. *International Journal of Wilderness* 9(1), 20-27.
- Marion, J.L., & Cole, D.N. (1996). Spatial and temporal variation in soil and vegetation impacts on campsites. *Ecological Applications*, 6, 520-530.

- Marion, J.L., & Reid, S.E. (2001). Development of the United States 'Leave No Trace' programme: A historical perspective. In M.B. Usher (Ed.), *Enjoyment and understanding of the natural heritage*. Edinburgh, Scotland: Scottish Natural Heritage & the Stationery Office.
- McCool, S.F., & Christensen, N.A. (1996). Alleviating congestion in parks and recreation areas through direct management of visitor behavior. In D.W. Lime (Ed.), *Congestion and crowding in the National Park System: Guidelines for management and research*. (MAES Misc. Pub. 86-1996). St. Paul, MN: Department of Forest Resources and Minnesota Agricultural Experiment Station, University of Minnesota.
- McGuire, W. J. (1985). Attitudes and attitude change. In G. Lindzey & E. Aronson (Eds.), *The handbook social psychology* (3rd ed., Vol.2., pp. 233-346). New York: Random House.
- Metzger, T., & McEwen, D. (1999). Measurement of environmental sensitivity. *The Journal of Environmental Education*, 30(4), 38-39.
- Oliver, S.S., Roggenbuck, J.W., & Watson, A.E. (1985). Education to reduce impacts in forest campgrounds. *Journal of Forestry*, 83(4), 234-236.
- Overton, D.J. (1991). *Campsite change due to minimum and traditional impact behavior practices*. Unpublished doctoral dissertation. Fort Collins: Colorado State University.
- Pooley, J.A., & O'Connor, M. (2000). Environmental education and attitudes: Emotions and beliefs are what is needed. *Environment and Behavior* 32(5), 711-723.
- Reid, S.E. & Marion, J.L. (2005). A comparison of campfire impacts and policies in seven protected areas. *Environmental Management*, 36(1), 48-58.
- Roggenbuck, J.W. (1992). Use of persuasion to reduce resource impacts and visitor conflicts. In M.J. Manfredo (Ed.), *Influencing human behavior: Theory and applications in recreation, tourism, and natural resource management*, (pp. 149-208). Champaign IL: Sagamore.
- Vander Stoep, G.A., & Roggenbuck, J.W. (1996). Is your park being "loved to death?": Using communications and other indirect techniques to battle the park "love bug." In D.W. Lime (Ed.), *Congestion and crowding in the National Park System: Guidelines for management and research*. (MAES Misc. Pub. 86-1996). St. Paul, MN: Department of Forest Resources and Minnesota Agricultural Experiment Station, University of Minnesota.
- Westphal, J.M., & Halverson, W.F. (1985). Assessing the long-term effects of an environmental education program: A pragmatic approach. *The Journal of Environmental Education*, 17(2), 26-30.
- Zelezny, L.C. (1999). Educational interventions that improve environmental behaviors: A meta-analysis. *The Journal of Environmental Education* 31(1), 5-14.
- Zint, M., Kraemer, A., Northway, H., & Lim, M. (2002). Evaluation of the Chesapeake Bay Foundation's conservation education programs. *Conservation Biology*, 16, 641-649.